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COMMUNITY WATER SUPPLY STUDY. SIGNIFICANCE OF NATIONAL FINDINGS

Bureau of Water Hygiene,
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Significance of National Findings

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Environmental Health Service
Bureau of Water Hygiene

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Bureau of Water Hygiene
Environmental Health Service
U.S. Public Health Service
Department of Health, Education and Welfare
July, 1970
Washington, D. C.

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FOREWORD

The ecological crisis with which our Nation, and the world, are today confronted has been building for many years. Yet, for many, the magnitude of the damage which we have inflicted on our environment, in ignorance and carelessness, has come as a recent, stunning surprise. However, the urgency of our environmental problems can no longer be ignored or denied. President Nixon expressed the National mood about these sobering realities when he declared that "the nineteen seventies absolutely must be the years when America pays its debt to the past by reclaiming the purity of its air, its waters and our living environment."

Of special concern is the fact that the waste products of our highly urbanized and technological society --- many of them not even identified --- which pollute our land, air, and water, persist in the environment, and react, one with another, in complex and little understood ways, to affect the life cycles of plant, animal, and human organisms.

Our water resources, more perhaps than any other, illustrate the interaction of all parts of the environment, and also the recycling process that characterizes every resource of the biosphere. Everything that man injects into his environment --- chemical, biological, or physical --- can ultimately find its way into the earth's water and these contaminants must be removed, by nature or by man, before the water is again potable.

Concern for our water quality until quite recently has centered principally on the danger of bacteriological contamination from inadequately treated sewage discharged into our rivers and streams. Today we are confronted with the fact that chemical pollution of source waters poses additional, and possibly even more difficult, problems. Moreover, we deceive ourselves if we assume that even the most complete and effective treatment of municipal and industrial wastes can ever remove all threats of water contamination.

In a world subjected to growing burden of interacting pollutants, many other sources of contamination exist, so that the quality and safety of our drinking water must finally depend upon constant vigilance and application of the best techniques of water treatment and distribution.

That only recently has attention been focused on the problems of maintaining safe drinking water is illustrative of the dangerous complacency with which we have viewed the whole spectrum of environmental ills. This report by the Bureau of Water Hygiene, Environmental Health Service, represents the first real attempt to determine, on a nationwide basis, the efficacy of current practices in water treatment and to assess future prospects for maintaining safe, high quality drinking water.

It may be concluded, on the basis of the survey findings, that, while the overwhelming majority of the people of the United States can be assured that the water they drink today is safe, several million drink water containing potentially hazardous amounts of chemical or bacteriological contamination. Clearly there is an immediate need, in many localities, for upgrading present water treatment and distribution practices.

Moreover, as in so many other aspects of our environmental situation, the findings are not reassuring with regard to the future. It seems abundantly clear that we will need, in the years ahead, to give increasing attention to the broad problems of water supply in order to assure the public of an adequate supply of safe drinking water on a continuing basis.

Charles C. Johnson, Jr.
Assistant Surgeon General
Administrator

SIGNIFICANCE OF THE NATIONAL COMMUNITY WATER SUPPLY STUDY

A Statement by the
Director of the Bureau of Water Hygiene

PREFACE

Contemporary American society recognizes a host of interrelated factors that determine the quality of urban life. In addition to the basic needs -- food, clothing and shelter -- we have recently begun to recognize two other daily necessities that were heretofore thought to be of unquestionable quality and available in unlimited quantities; ample quantities of clean air, from moment to moment, and safe drinking water, from hour to hour.

The Community Water Supply Study concerns the current and future healthfulness and dependability of the drinking water supplied to over 150 million Americans by community water supply systems. The remaining population drinks from private supplies. The purpose of the study was to determine the quality of drinking water being delivered to the over 18 million people in the study areas and the health risk factors that enabled scientists and engineers to evaluate the ability of these systems to continue to provide adequate supplies of safe water now and in the future. The Analysis of National Survey Findings of the National Community Water Supply Study (July 1970) is based on a survey of 969 representative public water supply systems located in nine areas of the Nation. This statement attempts to place the technical findings into a national perspective. It seeks to answer two questions about the nation's water supplies: (1) Are well established standards of good practice being applied to assure the quality and dependability of water being delivered to consumers' faucets today? and, (2) What needs to be done to assure adequate quantities of safe drinking water in the future on a National scale? While our study has helped provide answers to these important questions, not all the discussion that follows in this statement is derived solely from the results of this single investigation.

BACKGROUND

Americans generally assume that the water from their faucets is healthful, and free of bacterial or chemical contaminants that can bring disease. Usually, the assumption is correct. The drinking water supplies in cities and towns of the United States rank in quality, on the average, among the best in the world. Nevertheless, there is cause for serious concern about our drinking water. There are two good reasons for this paradox.

To begin with, it cannot be maintained that all of our drinking water is safe. It is true that the classical communicable waterborne diseases of years past -- typhoid fever, amoebic dysentery and bacillary dysentery -- were brought under control by the 1930's. However, we still have outbreaks of communicable disease from sewage contamination of water supply systems in the United States. Recent outbreaks are discussed later in this report. As we shall see in this report, we found evidence of bacterially contaminanted water being served to consumers in communities ranging in size from less than 500 to 100,000 persons.

Disturbing as it is to find such evidence, there is a second, more far reaching problem of considerable importance to the country. That problem is the ability of all our present municipal water supply systems to continue to deliver water of good quality and adequate quantity in the decades ahead to a rapidly rising population. This is made all the more difficult by the growing amount of chemical pollutants entering our lakes, streams and aquifers.

Current forecasts provide an indication of how much water we will be needing in the future. According to one calculation, we used 270 billion gallons of water per day in 1965 in support of industry, agriculture, and for domestic drinking purposes. By the year 2020, our water requirements. are expected to exceed 1300 billion gallons each day. But hydrologists estimate that the total usable surface water supply from rainfall is only 700 billion gallons per day.

Even today, when we return our used waters to streams or lakes we find ourselves using them over and over again. The need for multiple reuse of water will become greatly amplified in major sections of the country in years ahead. If the future population growth rate is only half of current projections, and even where desalinization of salt and brackish waters is a practical and economically feasible alternative, major sections of the country will find it increasingly necessary to practice multiple reuse in the years ahead. Much of the future problem relates to the need for having this water available when and where it is needed. For this reason, ground water has emerged as a significant source now accounting for more than 20 percent of the Nation's water supply requirements.

Where both surface and ground sources are insufficient, it will become necessary to directly recycle our wastewaters. This means taking wastewaters and using them over again in a closed system without first discharging them into our streams and lakes. With our present technology we cannot use water in this fashion for drinking, recreation or other intimate uses. It is true that during the past decade, much has been learned about the treatment of wastewaters for removal of some organic substances and bacteria, and processes for renovating wastewaters for direct reuse have even proceeded to the pilot plant stage. But the reuse of wastewaters over and over again presents us with new problems; with present treatment processes, chemicals would be concentrated, and therefore, new treatment processes must be developed; fail-safe warning systems must be found; and new methods must be developed to detect and remove such impurities as the pesticides and viruses which currently are present in almost undetectable concentrations. Little is known about the concentrations of carcinogens, antibiotics or hormones present in wastewaters.

Even though wastewater control efforts will be expanded in the future and are sorely needed to minimize future pollution of our drinking water sources, it is clear that water pollution control efforts alone cannot assure a safe drinking water quality. It is highly unlikely that even the best conventional waste treatment will produce a discharge of drinking water quality. As such, treatment does not remove all of todays known potential toxicants or biological agents prior to discharge. In addition, there are pollutants which have an effect on source of drinking water which are not subject to waste treatment. Such pollutants are found in uncontrolled runoff from our fields and forests, and from chemicals spilled in transportation accidents. Both of these examples adversely affect quality at the community water treatment plant intake. Both today and in the future, delivery of adequate supplies of safe water at the consumer's tap will be dependent upon properly designed, constructed and operated municipal water treatment plants and distribution systems.

SCOPE OF THE STUDY

The National Community Water Supply Study was designed to cover a variety of natural and demographic situations across the country. It surveyed 969 public water systems -- in the State of Vermont and in eight standard metropolitan statistical areas -- New York, New York; Charleston, West Virginia; Charleston, South Carolina; Cincinnati, Ohio; Kansas City, Missouri-Kansas; New Orleans, Louisiana; Pueblo, Colorado; and San Bernardino-Riverside-Ontario, California. The survey investigated every public water system in each of the designated areas. Twenty-two big city systems in the study areas served over 13 million people. The remaining 947 systems served 5 million people in communities of less than 100,000 people and 760 of those 947 systems each served populations of less than 5,000 people.

The survey was not expected to provide a perfect random sample of water supply systems throughout the country, but the results are reasonably representative of the status of

the water supply industry in the United States. As detailed in the Analysis of National Survey Findings, and in the nine supportive reports presenting findings for the specific study areas, the Public Health Service Drinking Water Standards of 1962 were used to evaluate both the current quality of drinking water and the health risks associated with the systems delivering that water.

Each water supply system was investigated to determine the quality of water being delivered to the consumer's tap, the adequacy of physical facilities and operating procedures, and the status of surveillance programs so necessary to the delivery of adequate quantities of safe water on a continuing basis consistent with the U.S. Public Health Service Drinking Water Standards. Two or more water samples, depending on the size of the community population, were analyzed for chemical, bacteriological and other constituents. Each sample indicated the quality of water at a particular point in time, and when all samples from a given system were evaluated together, the average quality of water being served during the study was determined.

The evaluation of each system was designed to identify deficiencies which could lead to a system failure in the future that, in turn, could lead to the delivery of potentially hazardous water quality to the consumer. Past records were studied to determine operational practices, including the frequency of past failures of equipment. The current condition of physical facilities was examined for such deficiencies as inadequate disinfection equipment in the event of an emergency, or finished water reservoirs poorly protected from contamination. The surveillance programs were reviewed with an eye on such problems as collection of bacteriological samples on a regular basis and the regular inspection of the distribution systems to prevent recontamination of the drinking water between the treatment plant and the consumer's tap.

FINDINGS IN THE STUDY AREAS

Drinking water quality defects and health risk problems involving poor operating procedures, inadequate physical facilities, and poor surveillance activities were found in both large cities and small towns irrespective of geographical location. In general, the larger systems, those serving in

excess of 100,000 persons including the 10.4 million people in the cities of New York, Cincinnati, Kansas City, and New Orleans, were delivering an "average" acceptable water quality consistent with the Drinking Water Standards. On this average basis, 86 percent of the approximately 18 million people covered by this study, or about 15.5 million served by 59 percent of the 969 systems investigated, were receiving good water during the study. The larger systems also evidenced better operation of treatment and distribution facilities. While sanitary defects were found in larger systems, the overall health risk was generally judged to be low, even though improvements in operational procedures and physical facilities are believed warranted in many instances.

Conversely, 41 percent of the 969 systems were delivering waters of inferior quality to 2.5 million people. In fact, 360,000 persons in the study population were being served waters of a potentially dangerous quality. This was particularly true of community systems serving less than 100,000 persons. Even where average quality was good, occasional samples were found to contain fecal bacteria, lead, copper, iron, manganese and nitrate and a few even exceeded the arsenic, chormium, and selenium limits. After all, people do not drink "average" water. They drink "samples" of water from their kitchen faucets or a drinking fountain at work or play. It is particularly important to note that communities of less than 100,000 people evidenced a prevalence of the water quality deficiencies and health risk potential. Some of the very small communities were even drinking water on a day-to-day basis that exceeded one or more of the dangerous chemical limits, such as selenium, arsenic or lead.

The major findings from the study, in the light of today's water treatment technology are as follows:

QUALITY OF WATER BEING DELIVERED

* 36 percent of 2,600 individual tap water samples contained one or more bacteriological or chemical constituents exceeding the limits in the Public Health Service Drinking Water Standards.

...9 percent of these samples contained bacterial contamination at the consumer's tap evidencing potentially dangerous quality.

..30 percent of these samples exceeded at least one of the chemical limits indicating waters of inferior quality.

..11 percent of the samples drawn from 94 systems using surface waters as a source of supply exceeded the recommended organic chemical limit of 200 parts per billion.

STATUS OF PHYSICAL FACILITIES

* 56 percent of the systems evidenced physical deficiencies including poorly protected groundwater sources, inadequate disinfection capacity, inadequate clarification capacity, and/or inadequate system pressure.
* In the eight metropolitan areas studied, the arrangements for providing water service were archaic and inefficient. While a majority of the population was served by one or a few large systems, each metropolitan area also contained small inefficient systems.

OPERATORS' QUALIFICATIONS

* 77 percent of the plant operators were inadequately trained in fundamental water microbiology; and 46 percent were deficient in chemistry relating to their plant operation.

STATUS OF COMMUNITY PROGRAMS

* The vast majority of systems were unprotected by cross-connection control programs, plumbing inspection programs on new construction, or continuing surveillance programs.

STATUS OF STATE INSPECTION AND TECHNICAL ASSISTANCE PROGRAMS

* 79 percent of the systems were not inspected by State or County authorities in 1968, the last full calendar year prior to the study. In 50 percent of the cases, plant officials did not remember when, if ever, a state or local health department had last surveyed the supply.

* An insufficient number of bacteriological samples were analyzed for 85 percent of the water systems -- and 69 percent of the systems did not even analyze half of the numbers required by the PHS Drinking Water Standards.

NATIONAL SIGNIFICANCE OF THE STUDY FINDINGS

Well established standards of good practice, in terms of the full application of existing technology, are not being uniformly practiced today to assure good quality drinking water. While most professionals hold the USPHS Drinking Water Standards in high esteem, the study shows that an unexpectedly high number of supplies, particularly those serving fewer than 100,000 people, exceeded either the mandatory or recommended constituent levels of bacterial or chemical content, and a surprisingly larger number of systems evidence deficiencies in facilities, operation and surveillance.

The National significance can be placed in perspective by considering the size-distribution of municipal water supply systems that were the subject of comprehensive facilities census conducted during 1963. At that time, 150 million Americans were being served by 19,236 public water supply systems including 73 million people dependent upon 18,837 small systems, each serving communities of less than 100,000 people. When these statistics are compared with the fact that over 40 percent of the small systems investigated during the current study evidenced current quality deficiencies on the average and both large and small communities were judged to be giving inadequate attention to quality control factors, there can be little doubt that this situation warrants major National concern.

Most of our municipal water supply systems were constructed over 20 years ago. Since they were built, the populations that many of them serve have increased rapidly -- thus placing a greater and greater strain on plant and distribution system capacity. Many systems are already plagued by an insufficient supply, inadequate transmission or pumping capacity, and other known deficiencies that become most evident during peak water demand periods. Moreover, when these systems were built, not enough was known to design a facility for the removal of toxic chemical or virus contaminants. They were designed solely to treat raw water of high quality for the removal of coliform bacteria. Such facilities are rapidly becoming obsolete as demands rise for water. The task in the future for our water treatment plants can be visualized by examining our population trend. By the year 2000 -- only 30 years from now -- our present population of about 205 million is expected to spurt to 300 million. By that time, it is expected that 187 million people (the total U.S. population just eight years ago) will be concentrated in four urban agglomerations -- on the Atlantic Coast, the Pacific Coast, on the coast of the Gulf of Mexico and on the shores of the Great Lakes. Most of the remaining population will be living in cities of 100,000 or more.

In the past, communities and industries were in the favorable position of being able to select the best source of supply consistent with their quantity and quality requirements. The demand for more water to quench the thirst of a growing population and meet the needs of expanding industry have led many people to ask how future quantity requirements will be satisfied. Concurrently, expanding water use comes at a time of greatly increased pollution of ground water aquifers, as well as streams, lakes and rivers. Historically and traditionally, ground water coming from its natural environment has been considered of good sanitary quality -- safe to drink,

if palatable. Nevertheless, 9 percent of the wells sampled during this survey showed coliform bacterial contamination. It seems fair to say that a similar situation prevails nationwide.

Chemical contaminants in our environment have been on the increase for about 25 years, due to the dramatic expansion in the use of chemical compounds for agricultural, industrial, institutional and domestic purposes. There are about 12,000 different toxic chemical compounds in industrial use today, and more than 500 new chemicals are developed each year. Wastes from these chemicals -- synthetics, adhesives, surface coatings, solvents and pesticides -- already are entering our ground and surface waters, and this trend will increase. We know very little about the environmental and health impacts of these chemicals. For example, we know very little about possible genetic effects. We have difficulty in sampling and analyzing them -- we have much greater difficulties in determining their contribution to the total permissible body burden from all environmental insults.

Consideration of the findings of this study leaves no doubt that many systems are delivering drinking water of marginal quality on the average, and many are delivering poor quality in one or more areas of their water distribution systems today. To add to this quality problem, the deficiencies identified with most water systems justifies real concern over the ability of most systems to deliver adequate quantities of safe water in the future.

RECOMMENDATIONS

Modern facilities operated by qualified personnel under adequate surveillance will provide high quality water with the lowest possible risk that current technology can offer. The following recommendations are made to those state and municipal officials concerned with the responsibility for safe, adequate water supply:

* Apply available water treatment and distribution technology, more intensively.
* Determine manpower needs of the state and county programs now in order to develop a program to provide technical assistance, training, and adequate surveillance to the Nation's numerous community water supply systems.
* Upgrade the skills of personnel responsible for the operations and maintenance of the water supply systems themselves, particularly in the case of those systems serving fewer than 100,000 people, through short courses, seminars, and correspondence courses to employees presently employed in the field as well as those wishing to enter it.
* Expand state laboratory resources to add the capability of routinely analyzing water samples for biological and chemical agents of health significance.
* Provide educational opportunities in water hygiene at the university level to assure the availability of qualified personnel to meet existing and future needs.

In addition to defining the need for improvements at the state and community level, this study's findings also show a need for research, development and planning to improve current practices and to provide adequate supplies of safe water in the future. The study clearly evidences the need to develop:

* Improved systems including surveillance procedures, to assure continuous and effective disinfection programs, particularly in smaller communities.
* Additional engineering research to simplify and lower the cost of removing excess nitrates and fluorides.
* Improved systems to control aesthetically undesirable concentrations of iron, manganese, hydrogen sulfide, and color, as well as taste and odor-causing organic constituents.

* Analytical surveillance techniques and control procedures to eliminate the deterioration that is occurring in water quality between the time the water leaves the treatment plant and the time it reaches the consumer.
* Improved planning to provide adequate quantities of safe water to the majority of our people who live in urban areas, and to assure optimum resource development and utilization to meet the needs of major population complexes.

History gives ample evidence of the inescapable penalties paid by past civilizations which failed to provide for the safety of their drinking water systems. Modern history shows that such waterborne diseases as typhoid, dysentery, and cholera are controllable and, in fact, were all but eliminated in the United States by the 1930's by applying the principles identified in the Drinking Water Standards. This study demonstrates that we have begun to backslide, which in turn, explains why it is that waterborne disease persists as evidenced by the epidemic at Riverside, California in 1965 which affected 18,000 people, the 30 percent gastroenteritis attack rate in Angola, New York in 1968 due to a failure in the disinfection system, and the 60 percent infectious hepatitis attack rate which afflicted the Holy Cross football team in 1969 as a result of the ineffective cross-connection control procedures. These recent episodes, reinforced by the findings of the current study, provide ample evidence of the increasing potential for similar episodes unless we improve water system operations consistent with currently accepted standards of practice.

We must also recognize numerous voids in existing technology which do not allow measurement of the current effectiveness of existing procedures. The current Drinking Water Standards do little more than mention viruses, neglect

numerous inorganic chemicals which are known to be toxic to man, and identify only one index that is supposed to cover the entire family of organic chemical compounds. These standards must be updated.

The need for knowledge about the health effects of waterborne contaminants is acute. Research is required, for example, to develop improved treatment control and surveillance procedures for viruses. The chronic long-term effects of chemical contaminants requires thorough investigation. For instance, we must determine the concentration levels at which numerous contaminants, such as mercury, molybdenium or selenium, cause adverse health effects. Similarly, we must mount a major attack on a host of synthetic organic chemicals which are growing at a rate of 500 new compounds per year. In addition to the threats posed by such well-publicized materials as pesticides, we now have to face a multitude of new organic chemical compounds. Recognizing our relatively fixed amount of ground and surface water supply, the increasing water needs of the general population and industry, and the need to reuse our available supplies to satisfy future demands, we can no longer afford to "wait and see what happens." We must begin to investigate before we introduce new compounds into the environment.

All this research is essential if we are to maintain at least the status quo for the current generation. These are issues confronting scientists and engineers today at all levels of government. But the overall water hygiene effort is this generation's responsibility to future generations. Indeed, answers to many of the currently identifiable research problems of today must be gained quickly if the current and future planners of our environment are to begin to formulate rational, economic and effective plans for the continued growth and development of our society.

James H. McDermott, P.E.
Director
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